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United States Fire Administration

Urban Search and Rescue in New York City Following a Commercial Building Collapse

Federal Emergency Management Agency
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Office of Firefighter Health and Safety

Urban Search and Rescue Program

As a result of a number of major emergencies including structural collapse both here and abroad over the last decade, the concept of urban search and rescue (USAR) has become increasingly recognized as an important element in integrated emergency response. These incidents include catastrophic earthquakes in California, the Philippines and Soviet Armenia and structural collapses in Brownsville, Texas, and New York City. Following Hurricane Hugo and the California earthquake in 1989, both of which served to draw attention to the need for improved urban search and rescue capabilities and rescue, the Federal Emergency Management Agency (FEMA) undertook a major initiative to establish a National Urban Search and Rescue system.

The initial goal of the program has been to establish 25 qualified USAR task forces placed strategically throughout the nation. These task forces provide the ability to respond to major incidents within a few hours of activation and offer a full range of capabilities in incident management; search rescue; specialty medical care for entrapped patients; and technical disciplines including structural engineering, heavy equipment operation, hazardous materials and communications

In addition, an Advisory Committee on the National USAR System has been formed consisting of federal government experts, state and local officials, and the private sector to guide further development of the System and to serve as a forum for discussing issues and exchange information related to urban search and rescue.

To complement the efforts of the Federal Emergency Management Agency in Urban Search and Rescue, the United States Fire Administration (USFA) has also initiated research and development and information dissemination efforts on USAR Study reports are being produced for USFA under its "Investigation of Urban Search and Rescue Incidents" program that will broaden the base of information available about USAR tactics, management and technology, and contribute to redwing the number and severity of casualties by highlighting the lessons learned, both the success and the failures, from such operations in the past. The investigation reports, such as this one, provide detailed information about the magnitude and nature of the incidents themsehq how the response to the incidents was carried out and managed; and the impact of these incidents on emergency respondents and the emergency response systems in the community. The United States Fire Administration greatly appreciates the cooperation and information it is receiving from the fire service. county and state offcials, and other emergency responders as this research progress.

Additional copies of this report can he ordered from the Federal Emergency Management Agency/United States Fire Administration. For more information about USFA's program, write United States Fire Administration, 16825 South Seton Avenue, Emmitsburg, Maryland 21727.

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Urban Search and Rescue in New York City Following a Commercial Building Collapse October 24, 1988

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OVERVIEW

Unapproved construction repairs to the bearing wall of a commercial building at 24 West 31st Street in midtown Manhattan caused the collapse of the entire side of the building, injuring 11 people and killing the building's owner. The remaining three sides of the structure remained free-standing, further endangering both victims and rescuers with the possibility of secondary collapse. A planned and coordinated Collapse Rescue Plan, implemented within the structure of the Incident Command System, facilitated the rescue of one trapped victim after nine hours, and limited the number of rescuer injuries to two.

A number of special problems occurred. Traffic jams surrounding the collapse site impeded some of the emergency response. The underground rapid transit system (subway) added to the ground vibration in the collapse area. Fifteen different train lines were forced to suspend service, including Amtrak, the

Long Island Railroad, New Jersey Transit, and Port Authority Trans-Hudson (PATH). Sensitive audio equipment, inserted in void spaces to listen for victim's cries or breathing, picked up a lot of background noise, making its use difficult.

ACKNOWLEDGEMENTIS

The Federal Emergency Management Agency, United States Fire Administration gratefully acknowledges the contributions of the publisher of *Fire Engineering*, Henry H. Dinneen, who graciously granted permission to excerpt portions of the February 1989 article "Collapse Rescue Operations." Interviews with Deputy Chief Vincent Dunn, Captain Raymond Downey, Rescue 1, FDNY, and Sergeant Schultheis, Emergency Service Unit, NYPD, provided the glue which binds a collection of divergent descriptions of circumstances into a cohesive and cogent whole. A special thanks to Sgt. Gerard "Pete" Berry, Public Information, NYPD for his cooperation and contributions during the media research.

DEFINITIONS

Exposure -- For the sake of accuracy and brevity, the sides of the building are numbered in accordance with the Incident Command System. The front of the building is side #l. The left side as you face the front is side #2; the back is side ***#3;*** and the right side is side #4.

Lean-To Collapse -- A collapse in which one end of the floor remains partially supported by the bearing wall, and the other end collapses onto the floor below, or collapses and remains unsupported.[1]

[1] Vincent Dunn, Collapse of *Burning Buildings: A Guide to Fireground Safety, New York: Fire* Engineering, 1988, pp 17-19.

"V" Collapse -- The collapse of a floor at the center of the floor beams. The broken center of the floor section collapses down upon the floor below, and both ends of the floor remain partially supported by the bearing wall?[2]

Pancake Collapse -- The collapse of one floor down upon the floor below in a flat, pancake fashion?[3]

Curtain-Fall Collapse -- The collapse of an exterior masonry wall that causes it to drop as if it were a curtain cut loose at the top.[4]

Tunneling -- A method of digging through collapse debris to connect two void spaces, or to connect a void space with the outside. It requires the construction of a supported tunnel through which rescuers can reach victims. The tunnel is not open at the top.

Trenching -- The construction of a path through collapse debris which is open at the top. The wails are supported to permit safe removal of a victim.

Shoring -- The use of structural members, beams, or prepared tools to support the construction of a tunnel or trench.

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[2] Ibid.

[3] Ibid.

[4] Ibid.

THE BUILDING

The building was a 6-story, 25-foot x 85-foot commercial structure, 60 to 70 years old, of brick and joist construction. (See Appendix A for drawings of the building and the stages of its collapse.)

According to New York City Building Commissioner Charles Smith, the building had already exceeded the occupancy load of 60 pounds per square foot before any construction repairs began.

THE COLLAPSE

The building's owner, Frank DeSantis, had engaged the services of JRV Construction to repair a large crack in the basement wall. The construction crew, without benefit of building permits or approvals, removed the l0-foot x 20-foot section of the basement wall which contained the crack. They did not support the void created. The load created on the remainder of the basement wall caused the remaining wail to bulge.

The construction crew hurriedly dug a 4-foot x 20-foot trench on the outside of the bulging wall and attempted to support it by filling the trench with cinder blocks and angled 2-inch x 4-inch studs.

At 3:07 p.m. the #4 wall collapsed in curtain fashion into the adjoining parking lot. Concurrently, the roof and floors collapsed, leaving walls #l, #2, and #3 severely damaged and free-standing, and floors two through six in an unsupported lean-to configuration. Office furniture, equipment, boxes, stock, and various other building contents hung precariously from the leaning floors. Twelve people were in the building when it collapsed.

Before the arrival of any emergency service personnel, the conditions were as follows:

Wall #1 -- Free standing, numerous cracks. Two men were sitting at window sills awaiting rescue, one on floor three, one on floor four.

Wall #2 -- The largest remaining wall, it was still attached to walls #1 and #3. It was somewhat supported by the masonry elevator shaft in the building.

Wall #3 -- Remained free-standing, numerous cracks.

Wall #4 -- Center two-thirds of the wall collapsed into the parking lot.

A passing New York City Fire Department (FDNY) messenger van observed the collapse and transmitted the alarm by voice.

THE COLLAPSE RESCUE PLAN

The Collapse Rescue Plan (CRP) instituted at this operation was based on years of experience and documentation. The New York CRP has as its basis the experiences of the London Fire Brigade during the bombing blitz of World war II.

As experience with building collapse grew, the CRP became firmly established. The purpose of the CRP is to maximize the chances of survival for the largest number of victims while minimizing the dangers to rescuers that these treacherous operations present.

The five step CRP is as follows:

1. ***Survey the collapse sit*** -- The first part of the survey should be a safety survey. Examine site for emergent hazards that would further endanger rescuers, e.g., gas leaks, unstable structures or structural members. Control or remove these dangers before committing rescue personnel. The second part of the survey should identify the areas of known and probable victims?[5]

2. ***Rescue victims who are on the surface the rubble--*** This, and step 3, will be the most productive in terms of successful victim rescue, but it is also very dangerous. Collapse debris shifts, and secondary collapses may occur.

3. ***Explore voids*** -- Most collapse configurations leave void spaces in which victims may be trapped and alive. In even the worst type of collapse in terms of survivability, the pancake collapse, voids can be created by furniture or other floor contents as well as collapsing structural members. In this particular collapse, a filing cabinet created a void which saved a man's life.

4. ***Selected debris*** -- To reach victims in known locations. This phase of the operation may require tunneling or trenching, and either would require shoring.

5. ***General debris removal*** -- After all known victims are removed, the rest of the rubble must be examined for any unexpected victims (a building visitor, a pedestrian walking by). This stage may require the use of heavy equipment. The work must proceed under the assumption that there may be additional victims alive. Each section of debris must be checked.

[5]Conversation with Vincent Dunn, Deputy Chief, FDNY, Sept. 22, 1992.

For more information about the CRP, see Vincent Dunn, *Collapse of Burning Buildings: Guide to Fire ground Safety,* New York: Fire Engineering, 1988; Vincent Dunn, "31st Street Collapse," W.N.Y.F., New York City Fire Department, 4th Issue, 1988, or Vincent Dunn, "Collapse Rescue Operations," *Fire Engineering,* February 1989.

THE OPERATION

Because the collapse had been called in and described by a member of the FDNY, dispatchers immediately added a Deputy Chief and two Rescue Units (R-l and R-3, the Collapse Unit) to the normal response of three engine companies, two truck companies, and a battalion chief. Upon receipt of confirming information, an additional rescue (R-4) was sent, along with another battalion chief, the Hazardous Materials Unit, Field Communications Unit, and two ladder companies.

The Police Department responded with approximately five Emergency Services Units (ESU's) bringing 10 officers. (An ESU is the Police Department's close equivalent of a fire department rescue squad.) Eventually this number increased to about 20 different units and 50 officers. Included were the Construction Accident Response Vehicle (CARV), two lighting trucks, the Special Operations Unit, the Remote Mobile Investigation Vehicle (RMIV), and a Temporary Headquarters Unit vehicle, all of which arrived shortly after the collapse. The CARV is a special unit which carries trenching, shoring, jacking, and pneumatic equipment. The RMIV carries special investigative tools and equipment, including video and audio equipment. Emergency Medical Services and Con Edison (the electric utility company) were also notified and responded.

A command post was established on 31st Street and the CRP was initiated. Two victims were removed from the windows of wall #l. Police officers and

EMS personnel assisted an additional nine victims who had ridden the collapsing building down into the parking lot. One victim, six months pregnant, rode the building down from the sixth floor, suffering only minor bruises and lacerations.

The Incident Commander (IC) ordered the shutdown of all building utilities and designated the lieutenant from Ladder 21 as the Victim Control Coordinator. The IC also directed the halt of all subway service in the area, fearful that the vibrations would trigger a secondary collapse of the remaining walls. A surveyor's transit was used to detect building movement, thereby warning rescue personnel of secondary collapse. At this point, 11 victims had been rescued, all without major injury.

Once steps 1, 2, and 3 of the CFW were completed, the IC removed all rescue personnel (PD, FD, EMS) to reevaluate the site before commencing with steps 4 and 5. While they are also the most dangerous, it is generally recognized that the most productive steps in the CRP are the first three: survey, surface rescue, and void rescue.

Step 4, selected debris removal, required the removal of some unstable walls by heavy equipment. The New York City Fire Department maintains a list of contractors with heavy equipment, and they are summoned, when needed, on a contractual basis. It took about three and a half hours to summon and place a l0-story crane into operation. This heavy crane removed the top three floors of wall #l and placed the debris in the street away from the collapse rubble. It is important to place debris in a place away from other collapse rubble so that it won't require further examination.

By about 8 p.m. that evening (five hours into the operation), the wall was dismantled. The collapse site was sectored; rescuers from the Police Department took the front (side #l), and the Fire Department took the rear (side #3).

Rescuers formed a human chain to hand dig out the collapse debris, passing the debris hand to hand. A human chain reduces the amount of walking that each rescuer must do, thereby diminishing the possibility of tripping falls or collapsing into weak areas Human chains also reduce rescuer fatigue. A video camera mounted on a telescoping 'painter's pole" was used to search void spaces for victims without endangering rescuers.

At approximately 11:00 p.m. the body of the building owner was discovered. Only 15 minutes later and 20 feet way, a female victim, age 29, was found alive and conscious by Firefighter Joseph Hodges of Ladder Co. 6. Pieces of machinery and boxes had created a void which saved her life. She was first examined by EMS and stabilized in place, and then rescue operations began. Within 30 minutes she was dug out and transported to Bellevue Hospital. She suffered severe muscle damage due to the crushing of her legs. There were no broken bones. The incident also caused injuries to 10 civilians, lacerations and contusions, and leg injuries to a firefighter and a police sergeant.

The major portion of the rescue operation concluded at approximately 1:00 a.m., October 25. All known building occupants had been accounted for, and fire, police, and EMS units began picking up their equipment and returning to duty. Since there was no way to account for the possibility of a pedestrian or unknown building visitor, fire department units stayed at the site to supervise demolition and removal operations for an additional 72 hours.

THE INCIDENT COMMAND STRUCTURE

At the time, the New York City Charter assigned the Police Department the responsibility for operations at all non-fire building collapses. At the command post at this incident, Chief of (Police) Department Robert Johnson relied heavily on the acknowledged expertise of the Fire Department, commanded

by Chief of Department Homer Bishop. After this successful operation, the mayor placed the Fire Department in charge of all future non-fire building collapse operations.

The Incident Command System (ICS) was used at this emergency. The command structure is reprinted from *Fire Engineering* with permission in Appendix B. The FDNY plan added some key positions to the ICS which are quite neccessary but may not come to mind during the initial phases of this type of emergency. These positions are as follows:

Collapse Plan Evaluator -- Advises the Planning Officer as to the sequence of the Collapse Rescue Plan, its current phase, and the adherence to the plan by operating units.

Building Officer Consultant -- Advises the Planning Officer as to the structural integrity of the collapse site, construction problems, and special equipment required.

Victim Trucking or Victim Control Officer -- In the confusion of multiple injuries and victims still trapped, combined with the rescue efforts of several emergency services, it is important to have one person responsible to account for every victim found, treated, transported for medical care (by whom and to where), and victims still missing.

Coordination of interagency operations is a major concern. Everyone wants to help. The key to success of the command structure at the 31st Street collapse was preparation. Senior police and fire officers had met and discussed roles and responsibilities in anticipation of such an event. The point was continually made during interviews that had it not been for this preparation, several uncoordinated command structures could have been established.

To emphasize the point, imagine yourself as a 25 year veteran of your agency, having achieved the rank of Deputy Chief. You pull up in front of a major disaster, and an individual from another agency, also a Deputy Chief, says, “We’ve set up our command post over here, and my department is in charge. This is what we want you to do. Without having preestablished interagency protocols, there can be delay or duplication in sorting things out.

Rescue operations at building collapses are so dangerous to victims and rescue personnel that coordinated efforts under a unified command are absolutely mandatory. The diversity and complexity of the tasks required demand that roles and relationships be well established before the need for them arises.

LESSONS LEARNED

This incident demonstrates the value of many of the current ideas about urban search and rescue. They are grouped below under Planning, Operations, and Special Equipment.

Planning

1. ***Hold planning meetings between Police, Fire, and EMS to identify roles, relationships, and responsibilities for an interagency emergency response.*** This should not have to be done for the first time during an emergency. “What If" scenarios should be developed for each possible type of emergency response: building collapse, plane crash, hazardous materials release, bomb scare/explosion, floods, hurricanes, etc. Protocols should be established, mutually agreed upon, and the information disseminated throughout all of the organizations. Interagency training would help the process.

2. ***Idenitfy specialized and operators that may be needed for ran Urban Search* and *Incident.*** This equipment may range from a surveyor's transit (used to detect building movement) to a 10-Story (or higher) crane. Compile lists of people and resources - called a Resource Directory in some locales. Pictures of the equipment are helpful. A wide range of specialized equipment was brought to the scene of this incident in a timely manner.

3. ***Consider what features in your community could complicate emergency operations.*** Subways generate vibrations, so do overhead highways and bridges. What features may impede the movement of specialized equipment? Low bridges, low weight roads or bridges, narrow or winding roads? Subway vibrations were a major concern during this incident; it was unclear as to the level of danger they posed.

4. ***Develop and train a Collapse Rescue Plan.*** One of the most dangerous parts of uncoordinated emergency operations is rescue personnel running around trying to help, doing what they think is right. For the safety of rescuers and victims, the most productive efforts are those which are planned and coordinated. New York evolved over a number of years the Collapse Rescue Plan, successfully used at this incident.

Operations

5. ***Institute a command structure.*** One which is widely known and almost universally used is the ICS.

6. ***Implement the Collapse Rescue Plan.*** The sequence of survey, surface rescue, void rescue, selected debris removal, general debris removal was followed in this incident successfully.

7. ***Immediately shut off all utilities.*** There will probably be breaks in each utility: water, gas, electric. Each has the potential to kill surviving victims and rescuers. Some in combination (electric and water; gas and electric) are even more dangerous than they are alone. Shut off the gas first as it has the potential for the most destruction. This was done in this incident and averted a potentially disastrous fire.

8. ***Place hose lines and master stream devices to protect against the possibility of fire.*** The presence of flammable liquids, gas, electricity, and roughedged wooden structural members is just the right combination for a rapid fire which would endanger both victims and rescuers. This precaution was taken.

9. ***Keep a member of the building department (preferably an engineer) at the command post to advise the IC.*** Technical expertise about the structural integrity of the remaining building or the soundness of rescue operations from a building official's point of view can be invaluable to the IC. The position of Building Officer Consultant was part of the ICS at this incident.

10. ***Obtain information from survivors about potential victims and their locations.*** The Police Department used detectives and the Fire Department used fire marshals (fire detectives) for this task as they are more experienced at interviewing people under extreme stress.

11. ***Collapses leave clues as to the location of victims.*** Victims fall or slide into areas with other debris. Look for them at the bottom end of a lean-to collapse, or at the bottom of the "V" in a "V" shaped collapse. This indicator was used to find one of the survivors in this incident.

12. **Place an emergency service worker in charge of any heavy eqiupment at** ***make sure they stay in contact with the IC.*** Operators of large equipment cannot be expected to watch the operation of their equipment and the movements of 10 or 20 rescuers. Nor can they operate their equipment independent of the operation. Operations were coordinated through emergency workers at this incident.

13. ***Heavy equipment must not operate in areas where rescuers are digging by hand.*** The potential for secondary collapse or rescuer injury is too high. Only one type of operation should be going on at a time, either manual search or heavy equipment operations. This, too, was done.

14. ***Rescuers must stay out of the area when heavy cables are being used to tow or pull.*** These cables have been known to snap, severely injuring or killing people in the area. This became of concern when plans were being made to pull down the remaining unsupported walls of the building.

15. ***The basements of collapsed structures must be searched.*** Basements are frequently unaffected by a building collapse and are great places for voids. Rescuers must also be aware that there may be sub-basements requiring search. If the water has not been shut off, these basement areas will fill with water, drowning the victims. If a rescuer is searching a basement with more than an inch of water on the floor, probe ahead with a tool to insure footing. If there is a sub-basement full of water, the rescuer could fall through the entrance and drown. Rescuers must also take precautions against the possibility of heavier-than-air toxic gasses and diminished visibility in below grade areas.

16. ***Basements can sometimes be used as access to the first floor for victims.*** This can save tremendous time and effort if trenching or tunneling from the top would otherwise be required.

17. ***During night time operations, make sure the site is well lit.*** Tripping, falling, and puncture hazards abound Several lighting trucks were used at this incident.

18. ***Minimize tripping and falling hazard and exhaustion by setting up human chains to remove debris rather than having one person pick up and carry the debris away.*** This requires having enough manpower on the site, as was the case at this incident.

19. ***Appoint Victim Tracking Officer as part of the ICS.*** Be sure to record the name, location found, EMS treatment, and transport (who transported and where victims were transported). This position was used at this incident.

20. ***When there is danger secondary collapse, do not try to pull down walls with cable.*** Try to shore them up, or if necessary, remove them by crane. Pulling down walls endangers victims and rescuers, and increases the amount of rubble requiring thorough search.

21. ***Never give up.*** *Victims have been found alive as long as eleven days after* they were trapped. One victim here was found alive about 10 hours into the rescue.

22. ***Document your operations with notes before you leave the the site.*** Take pictures if you can.

23. ***Secure the area before you leave.*** So that no one else is injured. There were no subsequent injuries at the site.

Special Equipment

24. ***A surveyor's transit, set up away from the collapse structure, can be used to identify building movement and the possibility of secondary collapse.*** Assign someone with a radio to stay with the surveyor. Have that person remain in contact with the command post. If there is wall movement of l/8 to l/4 inches, then collapse is likely. Remove all rescue workers. This monitoring was accomplished at this incident.

25. ***Certain other types of equipment will aid in victim search.*** **These include** remote video cameras, high sensitivity microphones that can be dropped into void spaces to listen for breathing or moaning, thermal imaging cameras to detect body heat, and specially trained dogs to search for victims. Cameras and microphones were used in this incident.

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Additional Readings

"Building Collapse." *New York Dairy News,* October 24, 1988.

Dunn, Vincent. *Collapse of Burning Buildings: A Guide to Fire ground Safety*. New York: Fire Engineering, 1988.

_____ "Collapse Rescue Operations." *Fire Engineering,* February 1989.

_____ "31st Street Collapse." *W.N.Y.F.,* 4th Issue, 1988.

Norman, John. "Lifesavers." *Firehouse,* December 1988.

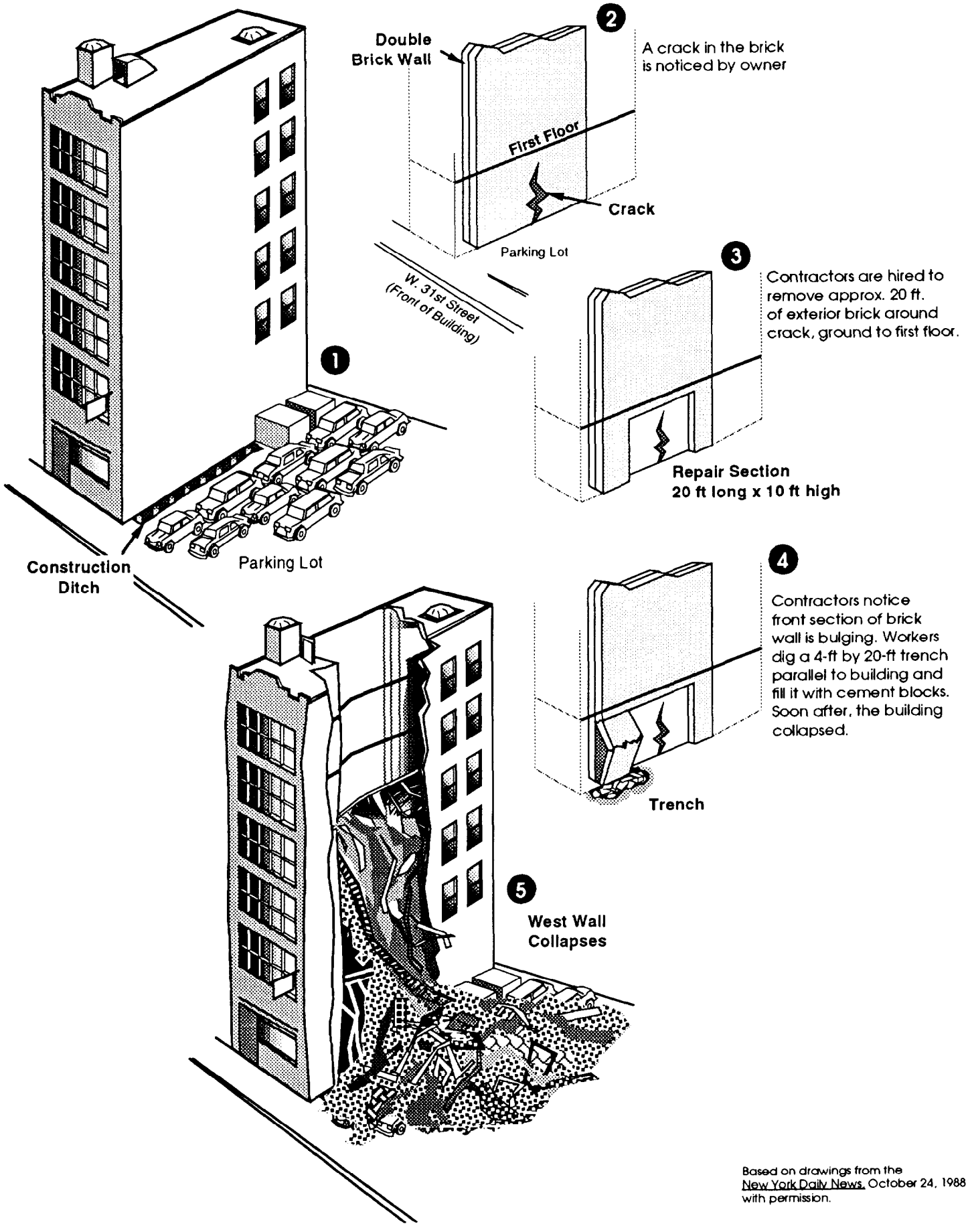
Appendices

A. Drawings of the Building and the Stages of Its Collapse

B. The ICS Command Structure Used in This Incident

Appendix A

Drawings of the Building and the Stages of Its Collapse



Based on drawings from the New York Daily News, October 24, 1988 with permission.

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Appendix B

The ISC Command Structure Used in This Incident

A Command System for Use at a Collapse Rescue Operation